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APPLICATION FOR LETTERS PATENT  
UNITED STATES OF AMERICA

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Be it known that I, **Greg R. Andrews**, residing at 70  
15 Home Avenue, Second Floor, Middletown, Connecticut, 06457,  
and I, **Robert S. Mendenhall**, residing at 9 Brainerd Avenue,  
Middletown, Connecticut, 06457, both being citizens of the  
United States of America, have invented certain new and  
useful improvements in

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**ANTI-ICING FORMULATIONS**

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of which the following is a specification.

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**INVENTOR'S REPRESENTATIVE:**

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**TITLE:**

ANTI-ICING FORMULATIONS

**RELATED APPLICATIONS:**

This non-provisional application claims the benefit of Provisional Application Serial No. 60/154,706, filed on September 18, 1999.

**TECHNICAL FIELD**

The present invention relates generally to anti-icing formulations; and, more specifically, to anti-icing and de-icing formulations produced from alcohol/polyol-based aqueous fluids, thickened by the combination of an acrylic emulsion and a water-swellaable layered clay mineral. Optional formulations include the addition of a surfactant combination comprised of a first surfactant with an hydrophilic/ lipophilic balance ("HLB")  $\leq 3$ , coupled with a second surfactant with an HLB  $\geq 19$ , and include the further optional addition of a water-activated polymer and other components. A second basic formulation describes a polyol-

based aqueous solution of polyvinyl alcohol with optional thickeners.

#### BACKGROUND OF THE INVENTION:

5       The problem of ice formation on surfaces is well known, and is addressed extensively in the prior art. There is still a need, however, for deicing/ anti-icing compositions which offer enhanced resistance to rain wash-off. Furthermore, there exists a need for effective deicing/  
10 anti-icing compositions which may be applied using simple light-duty hand-held sprayers.

Accordingly, it is an object of the present invention to provide a first form of anti-icing compositions which are easily removable from surfaces to which they are applied,  
15 and contain no polyvinyl alcohol, and to provide a second form that will set-up to form a rubber-like gel within several hours after mixing.

It is another object of the present invention to provide anti-icing compositions principally comprising an  
20 aqueous solution of monohydroxy and/ or polyhydroxy alcohols, thickened with a combination of an acrylic emulsion polymer and a water-swellaable, colloid-forming clay mineral.

It is still another object of the present invention to provide anti-icing compositions compatible with optional ingredients such as polyols, surfactants, pH-modifiers, friction-reducing agents, corrosion inhibiting agents, anti-oxidants, UV inhibitors, biocides, dyes, foam control agents, odor-modification agents, stabilizers, and the like.

It is yet another object of the present invention to provide anti-icing compositions that utilize non-toxic chemicals as freezing point depressants.

It is yet still another object of the present invention to provide anti-icing compositions having viscosity that may be adjusted for application of the composition through a variety of means.

#### BRIEF SUMMARY OF THE INVENTION:

The present invention provides substantial improvement to the art for a variety of applications. Formulations are described for compositions which may be applied using light-duty sprayers, yet still allow for higher viscosities, and, thereby, greater resistance to rain wash-off, than analogous prior-art formulations. Formulations are also described which provide enhanced resistance to water incursion. Formulations are further described for compositions

providing such an extreme level of resistance to wash-off that they are only suitable for applications where easy removal of the composition is not an issue.

Accordingly, anti-icing compositions are disclosed comprising an aqueous solution of monohydroxy and/ or polyhydroxy alcohols, thickened with a combination of an acrylic emulsion polymer and a water-swellaable, colloid-forming clay mineral. Optional additions include glycerine, and added surfactant combinations comprised of a first surfactant with an hydrophilic/ lipophilic balance  $\leq 3$  coupled with a second surfactant with an HLB 19. An example of such surfactant combination is a block copolymer of ethylene-oxide and propylene-oxide.

Further optional additions may include Teflon powder, graphite, pH-modifiers, corrosion inhibiting agents, anti-oxidants, UV inhibitors, biocides, dyes, foam control agents, odor-modification agents, stabilizers, and the like. Advantageously, the preferred formulations of the present invention utilize non-toxic chemicals as freezing point depressants.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT:

In describing the preferred and alternate embodiments of the present invention, specific terminology is employed for the sake of clarity. The invention, however, is not  
5 intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner to accomplish similar functions.

The present invention consists of formulations for  
10 anti-icing fluids. These fluids also have utility for deicing applications. The present formulations are of two basic types, which are most simply distinguished by the presence or lack of polyvinyl alcohol.

#### Type I Formulations:

  
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The formulations of the first basic type are designed to be easily removable from surfaces to which they are applied, and contain no polyvinyl alcohol. These  
formulations are comprised of combinations of the following  
20 components:

A. Freezing point depressant: This component will typically comprise between 20 to 80 weight percent of the total composition. The following are preferred:

a) One, two, or three carbon alcohols (i.e., methyl, ethyl, and propyl alcohols). These alcohols provide economy, low viscosity, rapid evaporation, and are quite flammable.

5 b) Two or three carbon glycols (i.e., ethylene glycol or propylene glycol). These diols are viscous, odorless, slow evaporating, and non-flammable.

c) Glycerol (1,2,3-propanetriol). Glycerol (Glycerine) is very viscous, odorless, extremely slow evaporating, and non-flammable. (For maximum viscosity and water resistance, these compositions should contain at least approximately 5% by weight glycerine).

10 d) Any combination of the above. The above components blend easily to yield compositions with a combination of the above- mentioned properties.

15 B. Water: This component will typically comprise between 20 to 80 weight percent of the total composition. The water does not have to be distilled or purified, although hard water may require pre-treatment or the addition of a sequestrant.

20 C. Acrylic-based emulsion polymer or copolymer: This component will typically comprise between 0.1 to 15 weight

percent of the total composition. Most preferred are associative, hydrophobically modified polymer emulsions.

D. Colloid-forming (water swellable) layered clay mineral: This component will typically comprise between  
5 0.05 to 5 weight percent, and most typically between 0.1 to 2 weight percent of the total composition. Preferred are natural or synthetic hectorites, montmorillonites and bentonites, and of these, purified or synthetic hectorites are especially preferred.

10 E. Nonionic surfactant with an HLB in the range of 1 to 3: This component is optional, and will typically comprise between 0.1 to 3 weight percent, and most typically between 0.5 to 2.0 weight percent of the total composition.

15 F. Nonionic surfactant with an HLB of 19 or above: This component is optional, and will typically comprise between 0.01 to 1.0 weight percent, and most typically between 0.05 to 0.5 weight percent of the total composition.

G. Polymeric water-activated thickening agent: This component is optional, and will typically comprise between  
20 0.01 to 10.0 weight percent, and most typically between 0.1 to 5.0 weight percent of the total composition. Preferred are polysaccharide thickeners, natural gum thickeners, marine algae colloids, and cellulose ether thickeners. Most



preferred is a polysaccharide known generically as Xanthan Gum.

H. pH adjusting agent: This component will typically comprise less than 0.5 weight percent of the total composition, and is, in any case, only required in an amount sufficient to adjust the pH upward to the range between 6 to 12, most preferably to between 7.5 to 10. Preferred are alkaline metal hydroxides and organic amine bases, although it may be advisable to avoid the use of tertiary amines as these can possibly interfere with the gel structure of these formulations.

I. Corrosion Inhibitors: These components are optional, and will typically comprise less than 1 weight percent of the total composition. Corrosion inhibitors useful as ingredients in alcohol/polyol based aqueous solutions are well known in the art, and selection may be made based upon the type of surfaces with which the present compositions are likely to come into contact, and how long and under what conditions they are likely to remain on that surface.

J. Powder lubricant: This component is optional, and is only used in compositions which are designed for applications such as locks or hinges, where it may be useful

to supplement the anti-icing function with one of lubrication. Preferred are graphite or Teflon powders, and the amounts will typically comprise between 0.1 to 10 weight percent of the total composition.

5 K. Miscellaneous additives: The composition may also contain various other functional ingredients such as anti-oxidants, UV inhibitors, biocides, dyes, foam control agents, odor-modification agents, stabilizers and the like. Each of these components will typically comprise less than  
10 1.0 weight percent of the total composition.

Examples of Type I Formulations:

Some examples of compositions produced by the aforementioned first basic type formulations are as follows,  
15 with the ingredients listed in approximate order of addition:

i. Slow-evaporating, non-toxic, viscous, thixotropic anti-icing fluid for application by trigger-type or other light-duty sprayers.

40 wt. %	Water
0.25 wt. %	LAPONITE® (synthetic hectorite clay: Laporte Industries, Ltd.)

0.75 wt. %	ALCOGUM® SL-70 (acrylic emulsion terpolymer: ALCO Chemical)
0.1 wt. %	PLURONIC® F108 (nonionic surfactant: BASF)
23 wt. %	Glycerine
20 wt. %	Propylene glycol
≈ 0.1 wt. %	AMP-95 (Aminomethyl propanol: Angus Chemical Co.)
15 wt. %	Isopropyl Alcohol
0.5 wt. %	PLURONIC® 31R1 (nonionic surfactant: BASF)
0.4 wt. %	Orange Oil 5 Fold (Frutarom-Meer Corporation)

ii. Viscous, thixotropic anti-icing fluid for use in automobile windshield washer reservoirs:

48.5 wt. %	Water
0.25 wt. %	LAPONITE® (synthetic hectorite clay: Laporte Industries, Ltd.)
0.5 wt. %	ALCOGUM® SL-70 (acrylic emulsion terpolymer: ALCO Chemical) Note: This ingredient is optional for windshield washer reservoir fluid.
0.05 wt. %	PLURONIC® F108 (nonionic surfactant: BASF)
15 wt. %	Ethylene glycol (substitute propylene glycol to produce a non-toxic product)
≈ 0.1 wt. %	AMP-95 (Aminomethyl propanol: Angus Chemical)

	Co.)
35 wt. %	Methanol (substitute isopropyl alcohol to produce a non-toxic product)
0.5 wt. %	PLURONIC® 31R1 (nonionic surfactant: BASF)
0.3 wt. %	Orange Oil 5 Fold (Frutarom-Meer Corporation) (Use when isopropyl alcohol is an ingredient.)

iii. Highly water-resistant, low-evaporation, non-toxic, anti-icing gels for application by hand-held spreaders or heavy-duty sprayers:

36 wt. %	Water
0.5 wt. %	LAPONITE® (synthetic hectorite clay: Laporte Industries, Ltd.)
10 wt. %	ALCOGUM® SL-70 (acrylic emulsion terpolymer: ALCO Chemical)
0.12 wt. %	PLURONIC® F108 (nonionic surfactant: BASF)
10 wt. %	Glycerine
42 wt. %	Propylene glycol
0.4 wt. %	KELZAN® (xanthan gum: Kelco Industrial Biopolymers)
1.2 wt. %	PLURONIC® 31R1 (nonionic surfactant: BASF)
≈ 0.2 wt. %	AMP-95 (Aminomethyl propanol: Angus Chemical

	Co.)
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iv. Low-evaporation, non-toxic, highly viscous anti-icing gel with lubricant; for application by injection into all types of locks:

35 wt. %	Water
1.0 wt. %	LAPONITE® (synthetic hectorite clay: Laporte Industries, Ltd.)
2.0 wt. %	ALCOGUM® SL-70 (acrylic emulsion terpolymer: ALCO Chemical)
0.15 wt. %	PLURONIC® F108 (nonionic surfactant: BASF)
40.0 wt. %	Glycerine
20 wt. %	Propylene glycol
0.5 wt. %	Zonyl® MP 1000 (PTFE powder: DuPont)
0.5 wt. %	KELZAN® (xanthan gum: Kelco Industrial Biopolymers)
0.7 wt. %	PLURONIC® 31R1 (nonionic surfactant: BASF)
≈ 0.2 wt. %	AMP-95 (Aminomethyl propanol: Angus Chemical Co.)

## Type II Formulations:

The formulations of the second basic type contain polyvinyl alcohol, and are designed to be extremely water resistant. These formulations are comprised of the  
5 following components:

A. Freezing point depressant: This component will typically comprise between 30 to 70 weight percent of the total composition. The following are preferred:

- a) Two or three carbon glycols.
- 10 b) Glycerol (Glycerine, 1,2,3-propanetriol).
- c) A combination of the above.

B. Water: This component will typically comprise between 30 to 70 weight percent of the total composition. The water does not have to be distilled or purified,  
15 although hard water may require pre-treatment or the addition of a sequestrant.

C. Polyvinyl alcohol: This component will typically comprise between 2 to 15 weight percent, and most typically between 6 to 10 weight percent, of the total composition.  
20 Fully-hydrolyzed, gel-resistant grades are most preferred.

D. Acrylic-based emulsion polymer or copolymer, or a crosslinked homopolymers or copolymers of acrylic acid: This component is optional, and will typically comprise

between 0.1 to 10 weight percent of the total composition.  
Most preferred are hydrophobically-modified compounds.

E. Polymeric water-activated thickening agent: This component is optional, and will typically comprise between  
5 0.1 and 10.0 weight percent of the total composition. Preferred are polysaccharide thickeners, natural gum thickeners, marine algae colloids, and cellulose ether thickeners. Most preferred is a polysaccharide known generically as Xanthan Gum.

10 F. Hydrogen peroxide: This component is optional, and will typically comprise between 0.02 and 1.5 weight percent of the total composition. This ingredient serves to lower the viscosity of polyvinyl alcohol solutions.

15 G. pH adjusting agent: This component will typically comprise less than 0.5 weight percent of the total composition, and is, in any case, only required in an amount sufficient to adjust the pH upward to the range between 7 and 12, most preferably to between 7.5 and 10. Strong bases, such as alkaline metal hydroxides can cause damage to  
20 the polyvinyl alcohol. Preferred are organic amine bases or ammonium hydroxide.

H. Corrosion inhibitors: These components are optional, and will typically comprise less than 1 weight

percent of the total composition. Corrosion inhibitors  
useful for use in polyol based aqueous solutions are well  
known in the art, and selection may be made based upon the  
type of surfaces which the present compositions are likely  
5 to come in contact with, and how long and under what  
conditions they are likely to remain on that surface.

I. Miscellaneous additives: The composition may also  
contain various other functional ingredients such as  
surfactants, anti-foaming agent, anti-oxidants, UV  
10 inhibitors, biocides, dyes, odor-modification agents,  
stabilizers and the like. Each of these components will  
typically comprise less than 1.0 weight percent of the total  
composition.

#### Examples of Type II Formulations:

15 Compositions produced by the aforementioned second  
basic formulation will set-up to form a rubber-like gel  
within several hours after mixing. Typically, therefore,  
these compositions will be made in two or more parts, which  
20 are then mixed together prior to use. An example is shown  
below of a three part formulation. Parts A and B are  
volumetrically approximately equal parts, with the  
ingredients listed in order of addition:



PART A:

82 wt. %	Water
0.5 wt. %	Hydrogen peroxide
0.07 wt. %	TRITON® X-100 (gel-inhibiting surfactant: Union Carbide)
17 wt. %	ELVANOL® 85-82 (polyvinyl alcohol: DuPont)
≈ 0.2 wt. %	Triethanolamine (sufficient to produce a pH of about 7-10 for the combined parts)

PART B:

99.3 wt. %	Glycerine
0.5 wt. %	Carbopol® ETD 2623 (polyacrylic acid carbomer: B.F. Goodrich)
≈ 0.2 wt. %	DREWPLUS® L-474 (foam control agent: Drew Industrial Div., Ashland Chemical)
≈ 0.02 wt. %	Any color dye to indicate whether Parts "A" and "B" are fully mixed

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PART C:

≈ 1 % by weight	KELZAN® (xanthan gum: Kelco Industrial
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of Part B	Biopolymers)
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Mixing Instructions for the above-described multi-part formulation:

Disperse part "C" into part "B". While stirring part  
5 "A", add the "B/C" mix to part "A" and mix thoroughly.  
Avoid over-mixing to minimize air entrapment.

While particular formulations have been set forth to  
describe and exemplify this invention, such are not intended  
10 to be limiting. Rather, it should be noted by those  
ordinarily skilled in the art that the within disclosures  
are exemplary only and that various other alternative  
formulations may be made within the scope of the present  
invention. Accordingly, the present invention is not  
15 limited to the specific embodiments illustrated herein, but  
is limited only by the following claims.